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March 10, 2011
(PBW Project No. 1352)

VIA FEDERAL EXPRESS

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**RE: FINAL REMEDIAL ALTERNATIVES MEMORANDUM
GULFCO MARINE MAINTENANCE SUPERFUND SITE
FREEPORT, TEXAS**

Dear Mr. Miller and Ms. Nann:

Please find enclosed four (4) copies (Mr. Miller) and one copy (Ms. Nann) of the Final Remedial Alternatives Memorandum (RAM) for the Gulfco Marine Maintenance Superfund Site. This memorandum was prepared by Pastor, Behling & Wheeler, LLC (PBW) on behalf of LDL Coastal Limited LP (LDL), Chromalloy American Corporation (Chromalloy) and The Dow Chemical Company (Dow). An electronic copy of the entire report in Adobe® format is provided on the DVD transmitted to Mr. Miller herewith. In accordance with Paragraph 52 of the amended Unilateral Administrative Order for the Site, effective January 31, 2008 (the amended UAO), I certify that I have been fully authorized by the above Respondents to submit this memorandum and to legally bind these Respondents thereto. Parker Drilling Company has recently begun participating in the Site work under an agreement it reached with the Respondents.

This Final RAM incorporates EPA's comments on the Draft RAM dated December 17, 2011 as provided in a February 23, 2011 letter from Mr. Miller. Those comments and our responses indicating how the comments have been incorporated into this Final RAM are attached to this letter. A redline-strikeout showing the text changes between the draft and final reports is also attached for your reference.

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Mr. Miller and Ms. Nann
March 10, 2011
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Please provide your approval of this final memorandum at your earliest convenience.
Should you have any questions, please do not hesitate to contact me at any time.

Sincerely,

PASTOR, BEHLING & WHEELER, LLC

A handwritten signature in black ink, appearing to read "Eric F. Pastor", written over the printed name.

Eric F. Pastor, P.E.
Principal Engineer

Enclosures

cc: Ms. Luda Voskov – Texas Commission on Environmental Quality (2 copies)
Mr. Doug McReynolds – EA Engineering, Science and Technology
Mr. Ron Brinkley – US Fish and Wildlife Service
Mr. Don Pitts – Texas Parks and Wildlife Department
Mr. Andy Tirpak – Texas Parks and Wildlife Department
Mr. Tommy Mobley – Texas General Land Office
Mr. Larry Champagne - Texas Commission on Environmental Quality

Attachment A

**EPA Comments on Draft Remedial Alternatives Memorandum and
Comment Responses**

Gulfc0 Marine Maintenance Superfund Site

Comments and Responses

REMEDIAL ALTERNATIVES MEMORANDUM (RAM)

1. Comment: (Section 1.2.1, p. 2): *The Memo states that restrictive covenants have been filed for all parcels at the site, and provides copies of the restrictive covenants filed for Lots 55, 56, and 57. The Memo shall include copies of the restrictive covenants for all of the parcels at the site. In addition, documentation confirming that the covenants have been deed recorded shall be provided.*

Response: Copies of restrictive covenants for all parcels at the Site are included in Appendix B. The text in Section 1.2.1 has been revised to indicate that copies of the restrictive covenants for all Site parcels are provided in Appendix B. Documentation confirming that the covenants have been deed recorded is provided on the page following each restrictive covenant in that appendix.

2. Comment: (Section 1.2.3, p. 6): *The Memo states that the extent of contamination potentially includes the area immediately adjacent to the site in off-site Lot 20. The Nature and Extent Data Report (PBW, May 20, 2009) stated that several chemicals were identified in Lot 20 at the edge of a dry dock facility associated with a former commercial marina. These chemicals were at significantly higher concentrations than observed in adjacent site samples, which suggested an off-site contaminant source. The Memo shall include this information regarding Lot 20 with supporting information including a description of Lot 20 sampling results compared to site sampling results, description of shallow soil sampling results, potential for migration from the Gulfc0 site based on a consideration of the sampling results, etc.*

Response: The following wording has been added to this section to address this comment: "A review of data (particularly lead and zinc concentrations) for the Lot 20 samples and Site samples to the east suggests the presence of an off-site contaminant source in the vicinity of a dry dock facility associated with the former commercial marina on Lot 20. As detailed in the NEDR, the sample from the 0 to 0.5 foot depth interval near the Lot 20 dry dock (sample location L20SB07 as shown on Plate 1) contained lead and zinc at concentrations of 985 mg/kg and 6,510 mg/kg, respectively. In contrast, the highest lead and zinc concentrations in samples from the same depth interval at nearby Site sample locations SA4SB18, SA5SB19, and SA6SB20 (see Plate 1) were 152 mg/kg and 414 mg/kg, respectively. In addition, the highest lead concentration in surface soil samples (0 to 1 inch depth interval) from Lot 20 locations L20SS09 and L20SS10 near the Lot 20 dry dock was 253 mg/kg, which is much lower than the aforementioned lead concentration of 985 mg/kg in the 0 to 0.5 ft depth interval sample at L20SB07. The lower surface soil (0 to 1 inch) sample concentration supports the interpretation that a contaminant source on Lot 20, rather than airborne transport of surface soil from Site areas to the east, is the source of the elevated metals concentrations observed in that area of Lot 20."

3. Comment: (Section 1.2.3, p. 6): *The Memo states that the vertical extent of chemicals of interest at concentrations above the evaluation criteria is limited to depths less than four feet. The recent soil samples collected during the tank removal found chemicals of interest exceeding the criteria at a depth of 4 ½ feet. The Memo shall be revised to include this information.*

Response: The following wording has been added to this section to address this comment: "A localized area of visible hydrocarbon-stained soil containing some COIs at concentrations above extent evaluation criteria was observed below Tank No. 6 in the North Containment Area of the

AST Tank Farm during performance of the TCRA. As detailed in the Removal Action Report, visibly impacted soil in this area extended to approximately 5.5 feet below ground surface at specific locations beneath the former location (footprint) of Tank No. 6.”

4. Comment: (Section 1.2.3): *The memo shall include a description of the stained soil that is located below the former above ground storage tanks. This description shall include the type and thickness of overlying material, the depth range of the stained area, the contaminants and concentrations present at levels above the screening levels, and an assessment of any risks. A recommendation shall be made regarding the need for any further action regarding this stained soil area.*

Response: The following wording has been added to this section to address this comment: “During the excavation of the area beneath Tank No. 6 and adjacent Tank No. 2, the subsurface material present from the ground surface to approximately 2 to 2.5 feet bgs was observed to consist of fill material (including caliche base material and clay). Outside of the Tank Nos. 2 and 6 footprints, this fill material was not visibly impacted. Except for a thin (approximately 0.2 feet thick) zone of black staining along the contact between the base of the fill and original ground surface (approximately 2 feet bgs), there was no visible staining below 2.5 feet bgs south and west of Tank No. 2. Concentrations of several VOCs [benzene, chloroform, ethylbenzene, isopropylbenzene, tetrachloroethene (PCE) and trichloroethene (TCE)] in one or more samples collected from the Tank Nos. 2 and 6 excavation area exceeded screening value comparison criteria, with concentrations ranging from less than one mg/kg to as high as 1,660 mg/kg (a complete data table is provided in the Removal Action Report). The predicted risks for these concentrations were within EPA’s acceptable or target risk range for carcinogens (10⁻⁴ to 10⁻⁶ risk) and below a target hazard quotient of one for non-carcinogens, and thus no further action in this area is recommended.”

5. Comment: (Section 1.2.3): *The memo shall include a description of the debris pile that is located adjacent to the southern end of the former surface impoundments. This description shall include the type and thickness of overlying material, the depth of the contaminants, the contaminants and concentrations present at levels above the screening levels, and an assessment of any risks. A recommendation shall be made regarding the need for any further action regarding the debris pile area.*

Response: The following wording has been added to this section to address this comment: “Within the extent of North Area soil contamination, a small localized area of buried debris (rope, wood fragments, plastic, packing material, etc.) was encountered at depths of three feet bgs or more in the subsurface (below overlying clay soils) south of the former surface impoundments. Soil samples were collected from locations NE3MW05, SB-204, SB-205, and SB-206 (Plate 1) within this area. The projected extent of the buried debris area was estimated based on data from these locations and a June 1974 aerial photograph in which what appears to be the area is visible (Appendix C). Multiple samples were collected from these borings with sample depths for laboratory analyses generally corresponding to one foot depth intervals immediately above observed debris, immediately below the debris, and within the approximate center of the observed debris layer. The laboratory was unable to analyze the 3- to 4-foot depth interval sample (the debris interval sample) at boring location SB-205 for organic analytes due to solidification of the sample extracts during the concentration step of the analyses. Such solidification is consistent with olfactory and visual indications of naphthalene in this sample at the time of collection. Naphthalene concentrations in nearby SB-204 and SB-206 samples did not exceed extent evaluation comparison values. Based on these data and the lack of visual and olfactory indications of naphthalene observed during the drilling of those borings, the area containing

naphthalene in buried debris or adjacent soils appears limited to the vicinity of SB-205. As detailed in the RI Report, concentrations of several COIs (Arochlor-1254, arsenic, iron and lead) in debris area samples exceeded extent evaluation comparison values, with concentrations ranging from 6.35 mg/kg (Arochlor-1254) to 128,000 mg/kg (iron). The predicted risks for these concentrations were within EPA's acceptable or target risk range for carcinogens (10⁻⁴ to 10⁻⁶ risk) and below a target hazard quotient of one for non-carcinogens. Based on this information, and given the depth of the debris relative to the ground surface (at least three feet bgs), and the limited and stable nature of groundwater impacts in this area (see groundwater discussion below), no further action in this area is recommended."

6. Comment: (Section 1.2.4, p. 8): *The Memo states that a detailed contaminant fate and transport discussion will be provided in the future Remedial Investigation (RI) Report, and that key considerations from that discussion are included in the Memorandum. The Memo shall also state that the approved RI Report will provide the ultimate results regarding the nature and extent of contamination at the site, and any findings from the approved RI Report that are not consistent with statements in this Memo will be addressed as appropriate in the Feasibility Study for the site.*

Response: The requested statement has been added to this section.

7. Comment: (Section 1.2.5, p. 11): *Several site areas discussed in the Memo were not included in the Baseline Ecological Risk Assessment (BERA) as explained in the Final BERA Problem Formulation and Final BERA Work Plan and Sampling and Analysis Plan. Those areas shall be summarized in the Memo, including a summary of why there were not included in the BERA.*

Response: The following wording has been added to this section to address this comment: "Several Site areas discussed in this RAM were not included in the BERA, as explained in the Final BERA Problem Formulation (URS, 2010a) and Final BERA WP/SAP. As noted in Section 7.0 of the Final BERA Problem Formulation, these areas include: (1) the AST Tank Farm, where a TCRA has now been preformed; (2) the former surface impoundments cap, where cap repair activities will be performed as part of the operation and maintenance program described in Section 1.2.3 above; and (3) South Area soils, where the nature of the disturbed habitat and past, current and anticipated future land use (including the restrictive covenants for only commercial/industrial land use) obviated the need for consideration of soil exposure pathways in this area in the BERA."

8. Comment: (Section 1.2.5, p. 12): *The Memo discusses ecological risks for the site. Because an approved Baseline Ecological Risk Assessment (BERA), which is not final at this time, will be the ultimate determination of ecological risks at the site, a statement shall be included that the approved BERA will determine the actual ecological risks for the site, and any BERA findings that are not consistent with statements in this Memo will be addressed as appropriate in the Feasibility Study for the site. In addition, the last sentence of the next to the last paragraph on page 12, which begins with "Accordingly and consistent with discussions ..." shall be deleted.*

Response: The referenced sentence has been deleted and the following statement has been added at the end of this section: "The BERA Report, once approved, will provide the ultimate determination of actual ecological risks for the Site, and any BERA findings that are not consistent with statements in this RAM will be addressed as appropriate in the FS for the Site."

9. Comment: (Section 2.2, p. 13 and others): *The Memorandum included text regarding the former surface impoundments and their consideration for development of remedial action*

objectives, general response actions, technology identification and screening, and development of alternatives. The former surface impoundments were closed in 1982 in accordance with a state approved closure plan. The Human Health Risk Assessment completed in 2010 determined that there are no unacceptable cancer risks or non-cancer hazard indices at the impoundments. There are risks resulting from ground water at the site as addressed elsewhere in the Memo. During the Remedial Investigation the cap thickness was found to range from 2.5-feet to greater than 3.5-feet and had ruts in the cap. The state approved closure plan required that the cap be 3-feet thick. Maintaining the cap at the required thickness is important to minimize the potential for infiltration through the cap. Because the cap does not currently meet the thickness requirements defined within the state approved closure plan, the Memo shall be revised to provide for the repair of the cap to meet those approved closure requirements as part of an operation and maintenance program for the site, including regular inspections and repairs as necessary in the future. The text in the Memo regarding remedial action objectives, general response actions, technology identification and screening, presumptive remedies, and development of alternatives for the cap shall be removed and replaced with text to the effect that the cap will be repaired to meet the requirements of the approved state closure plan. Further, the Memo shall state that where possible, the use of heavy equipment in marsh areas shall be limited to avoid causing harm to un-impacted sediment habitat.

Response: The text regarding remedial action objectives, general response actions, technology identification and screening, presumptive remedies, and development of alternatives for the cap (former Sections 2.2.1, 2.3.1, 2.4.1, and portions of Section 3.1, respectively) has been removed. Table 2 (Screening of Former Surface Impoundment Remediation Technologies) has been removed and all subsequent tables renumbered accordingly. The cost evaluation tables for Alternatives 2 and 3 (now Tables 4 and 5, respectively) have been modified to remove the cost elements associated with the cap repair. Section A.4.1 of Appendix A (pertaining to action-specific ARARs associated with the cap repair) has been deleted.

The following text has been added to the discussion of the former surface impoundments in Section 1.2.3: “The cap investigation and inspection findings described above indicate the need for cap repair activities, specifically the restoration of a three-foot thick clay layer throughout the cap and repair of rutted areas, to meet the requirements of the aforementioned TWC-approved closure plan. These cap repair activities will be performed as part of a cap operation, maintenance, and inspection program, which will include regular inspections and repairs as necessary in the future to ensure the continued performance of the cap in accordance with the closure plan requirements. Since preparation and implementation of such a cap operation and maintenance program are Site maintenance issues and not remedial activities, the cap repair and plan preparation work is not considered in the development and evaluation of remedial alternatives herein. Where possible, the use of heavy equipment in marsh areas during cap repair, operation and maintenance activities will be limited to avoid causing harm to un-impacted sediment habitat.”

10. Comment: (Section 2): *Compliance with the Migratory Bird Treaty Act (MBTA) was not identified as requirement for the site. The MBTA prohibits the intentional and unintentional taking of migratory birds, including their nests and eggs, except as permitted by the U.S. Fish and Wildlife Service. Compliance with the MBTA shall be included as a requirement for work at the site. Any grading and clearing of brush from the cap during the nesting season (usually April 1 – July 15), shall be proceeded by a survey conducted by a qualified biologist. The survey shall investigate the vegetation growing on the cap for nests. If active nests are identified they shall be avoided until the young have fledged or the nests have been abandoned.*

Response: The following text has been added to the end of the discussion of the former surface impoundments in Section 1.2.3: “In addition, compliance with the Migratory Bird Treaty Act (MBTA) will be included as a requirement for the cap repair and other work at the Site. More specifically, grading and clearing of brush from the cap during the nesting season (usually April 1 – July 15) will be preceded by a survey conducted by a qualified biologist. The survey will investigate the vegetation growing on the cap for nests. If active nests are identified they will be avoided until the young have fledged or the nests have been abandoned.”

11. Comment: (Section 2.2, p. 13): *The Memo states that it is anticipated that the remedial action objectives for the site will not be based on ecological endpoints given the lack of potential risk to these receptors. Because an approved BERA, which is not final at this time, will be the ultimate determination of ecological risks at the site, a statement shall be included that the approved BERA will determine the actual ecological risks for the site, and any BERA findings that are not consistent with statements in this Memo will be addressed as appropriate in the Feasibility Study for the site.*

Response: The following wording has been added to the first paragraph in this section to address this comment: “The approved BERA will determine the actual ecological risks for the Site, and any BERA findings that are not consistent with statements in this RAM will be addressed as appropriate in the FS for the Site.”

12. Comment: (Section 2.2.2, p. 15): *The Memo states that there are no complete exposure pathways for ecological receptors. The Memo shall be revised to state that there are no “currently” complete exposure pathways for ecological receptors.*

Response: The word “currently” has been inserted in the text as requested.

13. Comment: (Section 3.1, p. 22): *Alternatives 2 and 3 include fencing around the capped area, but the description does not provide for warning signs. Signs warning of the presence and potential danger of hazardous materials posted at regular intervals around the capped area shall be included as part of these alternatives.*

Response: The requested signage shall be included in the surface impoundments operation and maintenance plan. Per Comment No. 9, cap repair activities (including signage) have been removed from the remedial alternatives discussed in the RAM.

14. Comment: (Table 3): *For the UV Process Option under the General Response Action of on-site treatment of collected ground water, the Memo states that the process has moderate capital and moderate operation and maintenance costs, which is similar to other process options considered, but then eliminates the technology because it has higher overall costs than the other physical technologies. The memo shall clarify why the UV Process Option is considered to have higher overall costs.*

Response: This table (now Table 2) has been revised to indicate low capital and low operation and maintenance costs for the Low Profile Aeration Process Option, and to note that the UV Process Option has a higher overall cost than the Low Profile Aeration Process Option.

15. Comment: (Table 3): *For the in-situ treatment response actions, the effectiveness will be impacted by the heterogeneity of the geology in the area. For heterogeneous geologies, the injected materials are less effective in contacting the contamination, which results in less effective treatments. The Memo shall be revised to consider site heterogeneity in the effectiveness*

evaluation for these response actions.

Response: The “Effectiveness” column in this table (now Table 2) for the two in-situ treatment technologies (biological treatment and chemical treatment) has been revised to note that the effectiveness is complicated by the “generally low permeability and high heterogeneity of water-bearing units which would make complete reagent delivery difficult.”

16. Comment: *(Table 3): The preliminary site investigation results indicate that active biodegradation in the ground water may be occurring at the site. This discussion is included in the draft Remedial Investigation Report, which is currently under review. The impact on naturally occurring biodegradation from the in-situ chemical treatment process shall be considered under the effectiveness discussion for the in-situ chemical treatment.*

Response: The following wording has been added to the “Site Considerations/Comments” column of this table (now Table 2) for the chemical treatment remedial technology: “Depending on type and completeness of chemical treatment involved, chemical treatment may inhibit naturally occurring contaminant biodegradation currently being observed in Site groundwater.”

17. Comment: *(Table 3): Natural biodegradation is not listed in the screening of ground water remediation technologies. This shall be added to the table and screened with the other technologies, and considered for inclusion in the remedial action alternatives.*

Response: Natural biodegradation has been added as an in-situ biological treatment process option in this table (now Table 2). As indicated therein it was retained for further consideration in the RAM. The discussion of general response actions in Section 2.3 has been modified to include natural biodegradation as an inherent part of the monitoring/institutional controls response action. Similarly, the screening of technologies in Section 2.4 notes that natural biodegradation was retained as part of all remedial alternatives. The discussion of alternatives in Section 3.2 has been modified to note that natural biodegradation may contribute to some reductions in COI toxicity, mobility and volume over time.

18. Comment: *(Figure 5): This figure includes the Zone A monitoring wells, but not the Zone B or Zone C wells. Figure 5 shall be revised, or a new figure added, to show the locations of the Zone B and Zone C monitoring wells.*

Response: A new figure (Figure 6) has been added to show the Zones B and C groundwater monitoring locations. All subsequent figures have been renumbered accordingly. A reference to this figure has been added to the end of Section 1.2.3.

19. Comment: *(Appendix A, Section A.2): The citation for the Texas waste classification rules is given as “30 TAC Subchapter R.” The citation shall be changed to “30 TAC 335 Subchapter R.”*

Response: The citation has been revised as requested.

20. Comment: *(Appendix A, Section A.2): The second paragraph of this section refers to the Texas Risk Reduction Program protective concentration levels as “to be considered” guidelines. The reference to “to be considered” shall be removed and replaced with “criteria.”*

Response: References to “to be considered” in this section have been revised as requested.

Attachment B

**Redline Strikeout of Changes Between Draft and Final
Remedial Alternative Memorandum**

FINAL
DRAFT
REMEDIAL ALTERNATIVES MEMORANDUM

**FOR THE
GULFCO MARINE MAINTENANCE
SUPERFUND SITE
FREEPORT, TEXAS**

PREPARED BY:

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**DECEMBER 17, 2010
MARCH 10, 2011**

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LIST OF ACRONYMS

1,2,3-TCP - 1,2,3-trichloropropane
ARARs - Applicable or Relevant and Appropriate Requirements
AST - Aboveground Storage Tank
BaP - Benzo(a)pyrene
BERA - Baseline Ecological Risk Assessment
CERCLA - Comprehensive Environmental Response, Compensation and Liability Act
COI - Chemicals of Interest
COPEC - Chemicals of Potential Ecological Concern
CSM - Conceptual Site Model
DDT - dichlorodiphenyltrichloroethane
EPA - United States Environmental Protection Agency
FS - Feasibility Study
GRG - Gulfco Restoration Group
MBTA - Migratory Bird Treaty Act
NEDR - Nature and Extent Data Report
NPL - National Priorities List
O&M - Operation and Maintenance
PAH - Polynuclear Aromatic Hydrocarbon
PBW - Pastor, Behling & Wheeler, LLC
PCB - Polychlorinated Biphenyl
PRG - Preliminary Remediation Goal
PSA - Potential Source Area
PSCR - Preliminary Site Characterization Report
RAM - Remedial Alternatives Memorandum
RAO - Remedial Action Objective
RI - Remedial Investigation
RI/FS - Remedial Investigation/Feasibility Study
SLERA - Screening-Level Ecological Risk Assessment
SOW - Statement of Work
TCEQ - Texas Commission on Environmental Quality
TCRA - Time Critical Removal Action
TDS - Total Dissolved Solids
TNRCC - Texas Natural Resource Conservation Commission
TCE - Trichloroethene
UAO - Unilateral Administrative Order
USFWS - United States Fish and Wildlife Service

1.0 INTRODUCTION

The United States Environmental Protection Agency (EPA) named the former site of Gulfco Marine Maintenance, Inc. (Gulfco) in Freeport, Brazoria County, Texas (the Site) to the National Priorities List (NPL) in May 2003. The EPA issued a modified Unilateral Administrative Order (UAO), effective July 29, 2005, which was subsequently amended effective January 31, 2008. The UAO required Respondents to conduct a Remedial Investigation and Feasibility Study (RI/FS) for the Site. Pursuant to Paragraphs 17 through 28 of the Statement of Work (SOW) for the RI/FS, included as an Attachment to the UAO, a RI/FS Work Plan and a Sampling and Analysis Plan were prepared for the Site. These documents were approved with modifications by EPA on May 4, 2006 and were finalized on May 16, 2006. This Remedial Alternatives Memorandum (RAM) has been prepared in accordance with Paragraphs 44 and 45 of the SOW and Section 5.10 of the approved RI/FS Work Plan (the Work Plan) (PBW, 2006). The memorandum was prepared by Pastor, Behling & Wheeler, LLC (PBW), on behalf of LDL Coastal Limited LP (LDL), Chromalloy American Corporation (Chromalloy) and The Dow Chemical Company (Dow), collectively known as the Gulfco Restoration Group (GRG-), and Parker Drilling Company, who has recently reached an agreement to participate in the work being performed at the Site. Figure 1 provides a map of the Site vicinity, while Figure 2 provides a Site map.

1.1 PURPOSE AND ORGANIZATION

As described in the SOW, the purpose of the RAM is to develop a range of remedial alternatives and screen those alternatives in relation to the Remedial Action Objectives (RAOs) and the more specific Preliminary Remediation Goals (PRGs) for the Site. Consistent with EPA guidance regarding reporting and communication during the alternative development and screening process (Section 4.5 of EPA, 1988), the RAM provides written documentation of the methods, rationale, and results of the alternative screening. As such, the RAM provides the foundation for the more detailed analysis of alternatives in the FS.

Consistent with its role as an interim deliverable for the FS, the RAM has been organized to match the suggested format for the technology and alternative screening sections of the FS as provided in EPA, 1988. Site background information is provided below in Section 1.2. The identification and screening of technologies is discussed in Section 2. The development and

screening of alternatives is described in Section 3. Memorandum conclusions are provided in Section 4. References are listed in Section 5. Consistent with SOW requirements and as specified in the Work Plan, Appendix A summarizes the chemical, location, and action-specific Applicable or Relevant and Appropriate Requirements (ARARs) for each of the alternatives.

1.2 SITE BACKGROUND

1.2.1 Site Description

The Site is located in Freeport, Texas at 906 Marlin Avenue (also referred to as County Road 756) (Figure 1). The Site consists of approximately 40 acres within the 100-year coastal floodplain along the north bank of the Intracoastal Waterway between Oyster Creek approximately one mile to the east and the Texas Highway 332 bridge approximately one mile to the west. Marlin Avenue divides the Site into two primary areas (Figure 2). For the purposes of descriptions in this report, Marlin Avenue is approximated to run due west to east. The 20-acre upland property south of Marlin Avenue (the South Area) was created from dredged material from the Intracoastal Waterway and developed for industrial uses. It contains multiple structures, a dry dock, an aboveground storage tank (AST) tank farm, and two barge slips connected to the Intracoastal Waterway. The property to the north of Marlin Avenue (the North Area) contains some upland areas created from dredge spoil, but most of this area is considered wetlands, as per the United States Fish and Wildlife Service (USFWS) Wetlands Inventory Map (Figure 3). The North Area contains three adjacent closed surface impoundments and two ponds, the “Fresh Water Pond” immediately east of the impoundments, and a smaller pond to the southeast (referred to as the “Small Pond” hereafter). Site investigation activities (described below) identified a localized area of buried debris (rope, wood fragments, plastic, packing material, etc.) at depths of three feet below ground surface (bgs) immediately south of the former surface impoundments.

The South Area is zoned as “W-3, Waterfront Heavy” by the City of Freeport. This designation provides for commercial and industrial land use, primarily port, harbor, or marine-related activities. The North Area is zoned as “M-2, Heavy Manufacturing.” Restrictive covenants prohibiting any land use other than commercial/industrial and prohibiting groundwater use have been filed for all parcels within both the North and South Areas. Additional restrictions requiring any building design to preclude indoor vapor intrusion have been filed for Lots 55, 56 and 57 (see

Figure 2 for lot designations and boundaries). A further restriction requiring EPA and Texas Commission on Environmental Quality (TCEQ) notification prior to any building construction has also been filed for Lots 55, 56, and 57. Copies of ~~these restrictions~~ the restrictive covenants for Lots 55, 56, 57 all Site parcels, including documentation confirming recording of the covenants in the Brazoria County deed records are provided in Appendix B.

Adjacent property to the north, west and east of the North Area is unused and undeveloped. Adjacent property to the east of the South Area is currently used for industrial purposes while to the west the property is currently vacant and previously served as a commercial marina. The Intracoastal Waterway bounds the Site to the south. Residential areas are located south of Marlin Avenue, approximately 300 feet west of the Site, and 1,000 feet east of the Site.

1.2.2 Site History

The Site's operating history, as constructed through historical aerial photographs, personnel interviews, operating information, investigation report summaries, and regulatory agency correspondence, inspection reports and memoranda/communication records, is discussed in detail in the Work Plan. A summary of the RI activities at the Site is provided below.

RI activities at the Site were initiated in 2006. These activities included the collection and analyses of soil, sediment, surface water, groundwater, and fish tissue samples. Results of these analyses were summarized in a Nature and Extent Data Report (NEDR) (PBW, 2009), which was approved by EPA on April 29, 2009. A summary of the NEDR findings relative to the areas addressed in this RAM is provided in Section 1.2.3 below. A Draft RI Report (PBW, 2011a) dated February 4, 2011 is currently being revised based on EPA review comments.

A Final Baseline Human Health Risk Assessment (BHHRA) (PBW, 2010a) was prepared based on the data presented in the NEDR and was approved by EPA on March 5, 2010. A Final Screening-Level Ecological Risk Assessment (SLERA) (PBW, 2010b) was approved by EPA on June 9, 2010. Based on the SLERA conclusions, a Baseline Ecological Risk Assessment (BERA) was performed. Data collected for the BERA were presented in a Preliminary Site Characterization Report (PSCR) (URS, ~~2010b~~2010c), which was approved by EPA on December 8, 2010. The Draft BERA Report (URS, 2011) dated February 4, 2011 and is currently in preparation being revised based on EPA comments received on March 2, 2011.

A Time Critical Removal Action (TCRA) ~~is currently being~~ was performed to remove residual material in the tanks at the AST Tank Farm. The Draft Removal Action Report (PBW, 2011a2011b) documenting the TCRA activities is currently ~~in preparation~~ under EPA review.

1.2.3 Nature and Extent of Contamination

Key information pertaining to the former surface impoundments, and the nature and extent of chemicals of interest (COIs) in Site environmental media is summarized below. The nature and extent information data were previously provided in the NEDR (PBW, 2009a) and the Draft RI Report (PBW, 2011a).

Former Surface Impoundments

The former surface impoundments consist of three earthen lagoons used for the storage of wash waters generated from barge cleaning operations. Covering an area of approximately 2.5 acres combined, the impoundments were reportedly three feet deep and contained a natural clay liner (TNRCC, 2000). The impoundments were closed in 1982 in accordance with a Texas Water Commission (TWC) approved plan (Carden, 1982). Closure activities were reported to include: (1) removal of liquids and most of the impoundment sludges; (2) solidification of residual sludge that was difficult to excavate; (3) and capping with three-feet of clay and a hard-wearing surface (Guevara, 1989). As shown on a topographic survey of the area (Figure 4), the impoundments cap extends approximately 1.5 to 2.5 feet above surrounding grade. The cap crown slope is about 2% with slopes of 5 to 1 (horizontal to vertical) or less at the cap edge.

The construction materials, thickness, and condition of the former surface impoundments cap were evaluated through drilling and sampling of four borings through the cap, geotechnical testing of representative cap material (clay) samples, and performance of a field inspection of the cap, including observation of desiccation cracks, erosion features, and overall surface condition. As shown in Table 1, the surface impoundment cap thicknesses at the four boring locations ranged from 2.5 feet to greater than 3.5 feet. The geotechnical properties (Atterberg Limits, and Percent Passing # 200 Sieve) of the cap material as listed in Table 1 are consistent with those recommended for industrial landfill cover systems in TCEQ Technical Guideline No. 3 (TCEQ,

2009a) and the vertical hydraulic conductivities were all better (i.e., less) than the TCEQ guideline of 1×10^{-7} cm/sec.

The cap field inspection was performed on August 3, 2006. The cap appeared to be in generally good condition with no significant desiccation cracks or erosion features observed on the cap surface or slopes. The cap surface consisted of a partially vegetated crushed oyster shell surface overlying the clay layer. Some sporadic indications of animal (e.g., crab) penetrations of the cap surface were observed. Occasional debris (e.g., scrap wood and telephone poles) was observed on the surface and several large bushes (approximate height of three feet) were observed, mostly near the cap edges. Drilling rig and other heavy equipment (i.e. support truck) traffic across the western end of the cap in conjunction with Site investigation activities has resulted in surface rutting of the cap in this area.

The cap investigation and inspection findings described above indicate the need for cap repair activities, specifically the restoration of a three-foot thick clay layer throughout the cap and repair of rutted areas, to meet the requirements of the aforementioned TWC-approved closure plan. These cap repair activities will be performed as part of a cap operation, maintenance, and inspection program, which will include regular inspections and repairs as necessary in the future to ensure the continued performance of the cap in accordance with the closure plan requirements. Since preparation and implementation of such a cap operation and maintenance program are Site maintenance issues and not remedial activities, the cap repair and plan preparation work is not considered in the development and evaluation of remedial alternatives herein. Where possible, the use of heavy equipment in marsh areas during cap repair, operation and maintenance activities will be limited to avoid causing harm to un-impacted sediment habitat. In addition, compliance with the Migratory Bird Treaty Act (MBTA) will be included as a requirement for the cap repair and other work at the Site. More specifically, grading and clearing of brush from the cap during the nesting season (usually April 1 – July 15) will be preceded by a survey conducted by a qualified biologist. The survey will investigate the vegetation growing on the cap for nests. If active nests are identified they will be avoided until the young have fledged or the nests have been abandoned.

Nature and Extent of COIs in Environmental Media

The nature and extent of COIs in Site environmental media was investigated in the RI through the installation and/or collection of 17 Site Intracoastal Waterway sediment samples, 9 background Intracoastal Waterway sediment samples, 4 Site Intracoastal Waterway surface water samples, 4 background Intracoastal Waterway surface water samples, 33 Site fish tissue samples, 36 background fish tissue samples, 190 South Area soil samples, 10 background soil samples, 41 off-site soil samples, 4 former surface impoundment cap soil borings, 29 North Area soil samples, 56 wetland sediment samples, 6 wetland surface water samples, 8 pond sediment samples, 6 pond surface water samples, 30 monitoring wells, 8 temporary piezometers, 5 permanent piezometers, and three soil borings. Most of these samples were analyzed for the list of COIs identified in the RI/FS Work Plan. Supplemental sampling of wetland sediments was performed in June 2010 and then additional samples were collected as part of BERA activities as described in Section 1.2.5 below. The nature and extent investigation locations (except for background sample locations) are plotted on Plate 1. The investigation conclusions as reported in the NEDR and Draft RI Report are summarized by area/media below. The extent of COIs in these media were determined through comparisons to extent evaluation comparison criteria identified in the RI/FS Work Plan as described in the NEDR and Draft RI Report.

- Intracoastal Waterway Sediments – Certain polynuclear aromatic hydrocarbons (PAHs) and 4,4'-DDT were the only COIs detected in Site Intracoastal Waterway sediment samples at concentrations exceeding extent evaluation comparison values. These exceedences were limited to sample locations within or on the perimeter of the barge slip areas. Based on these data, the lateral extent of contamination in Intracoastal Waterway sediments, as defined by COIs concentrations above extent evaluation criteria, was identified as limited to several small localized areas within the two Site barge slips. A vertical extent evaluation does not apply to this medium.
- Intracoastal Waterway Surface Water – No COIs were detected at concentrations above their respective extent evaluation criteria in Intracoastal Waterway surface water samples collected adjacent to the Site.
- South Area Soils – COIs detected in South Area soils at concentrations exceeding extent evaluation criteria included certain metals, polychlorinated biphenyls (PCBs) and PAHs.

The lateral extent of contamination in South Area soils, as defined by COI concentrations above their respective extent evaluation criteria, was identified as limited to the South Area of the Site and potentially a small localized area immediately adjacent to the Site on off-site Lot 20 immediately to the west of the Site. A review of data (particularly lead and zinc concentrations) for the Lot 20 samples and Site samples to the east suggests the presence of an off-site contaminant source in the vicinity of a dry dock facility associated with the former commercial marina on Lot 20. As detailed in the NEDR, the sample from the 0 to 0.5 foot depth interval near the Lot 20 dry dock (sample location L20SB07 as shown on Plate 1) contained lead and zinc at concentrations of 985 mg/kg and 6,510 mg/kg, respectively. In contrast, the highest lead and zinc concentrations in samples from the same depth interval at nearby Site sample locations SA4SB18, SA5SB19, and SA6SB20 (see Plate 1) were 152 mg/kg and 414 mg/kg, respectively. In addition, the highest lead concentration in surface soil samples (0 to 1 inch depth interval) from Lot 20 locations L20SS09 and L20SS10 near the Lot 20 dry dock was 253 mg/kg, which is much lower than the aforementioned lead concentration of 985 mg/kg in the 0 to 0.5 ft depth interval sample at L20SB07. The lower surface soil (0 to 1 inch) sample concentration supports the interpretation that a contaminant source on Lot 20, rather than airborne transport of surface soil from Site areas to the east, is the source of the elevated metals concentrations observed in that area of Lot 20. The vertical extent of COIs at concentrations above extent evaluation criteria in unsaturated South Area soils was identified in the RI as limited to depths less than four feet, as no exceedences were observed in any of the RI samples from this depth.

- AST Tank Farm Soils - A localized area of visible hydrocarbon-stained soil containing some COIs at concentrations above extent evaluation criteria was observed below Tank No. 6 in the North Containment Area of the AST Tank Farm during performance of the TCRA. As detailed in the Removal Action Report, visibly impacted soil in this area extended to approximately 5.5 feet below ground surface at specific locations beneath the former location (footprint) of Tank No. 6. During the excavation of the area beneath Tank No. 6 and adjacent Tank No. 2, the subsurface material present from the ground surface to approximately 2 to 2.5 feet bgs was observed to consist of fill material (including caliche base material and clay). Outside of the Tank Nos. 2 and 6 footprints, this fill material was not visibly impacted. Except for a thin (approximately 0.2 feet thick) zone of black staining along the contact between the base of the fill and original

ground surface (approximately 2 feet bgs), there was no visible staining below 2.5 feet bgs south and west of Tank No. 2. Concentrations of several VOCs [benzene, chloroform, ethylbenzene, isopropylbenzene, tetrachloroethene (PCE) and trichloroethene (TCE)] in one or more samples collected from the Tank Nos. 2 and 6 excavation area exceeded screening value comparison criteria, with concentrations ranging from less than one mg/kg to as high as 1,660 mg/kg (a complete data table is provided in the Removal Action Report). The predicted risks for these concentrations were within EPA's acceptable or target risk range for carcinogens (10^{-4} to 10^{-6} risk) and below a target hazard quotient of one for non-carcinogens, and thus no further action in this area is recommended.

- North Area Soils – The only COIs detected in at least one North Area soil sample at concentrations exceeding their respective extent evaluation criteria were arsenic, iron, lead, 1,2,3-trichloropropane (1,2,3-TCP), ~~trichloroethene (TCE)~~, benzo(a)pyrene (BaP), dibenz(a,h)anthracene, and PCBs. The lateral extent of contamination in North Area soils, as defined by these few COI exceedences, was identified as limited to several small localized areas within this part of the Site where upland soils are present (i.e., within the area surrounded by wetlands). The vertical extent of COIs at concentrations above extent evaluation criteria in North Area soils extends to the saturated zone in some locations.
- Buried Debris Area - Within the extent of North Area soil contamination, a small localized area of buried debris (rope, wood fragments, plastic, packing material, etc.) was encountered at depths of three feet bgs or more in the subsurface (below overlying clay soils) south of the former surface impoundments-(Soil samples were collected from locations NE3MW05, SB-204, SB-205, and SB-206 as shown on Plate 1)-(Plate 1) within this area. The projected extent of ~~this the~~ buried debris area was estimated based on data from these locations and a June 1974 aerial photograph in which what appears to be the area is visible (Appendix C). Multiple samples were collected from these borings with sample depths for laboratory analyses generally corresponding to one foot depth intervals immediately above observed debris, immediately below the debris, and within the approximate center of the observed debris layer. The laboratory was unable to analyze the 3- to 4-foot depth interval sample (the debris interval sample) at boring location SB-205 for organic analytes due to solidification of the sample extracts during the concentration step of the analyses. Such solidification is consistent with olfactory and

visual indications of naphthalene in this sample at the time of collection. Naphthalene concentrations in nearby SB-204 and SB-206 samples did not exceed extent evaluation comparison values. Based on these data and the lack of visual and olfactory indications of naphthalene observed during the drilling of those borings, the area containing naphthalene in buried debris or adjacent soils appears limited to the vicinity of SB-205. As detailed in the RI Report, concentrations of several COIs (Arochlor-1254, arsenic, iron and lead) in debris area samples exceeded extent evaluation comparison values, with concentrations ranging from 6.35 mg/kg (Arochlor-1254) to 128,000 mg/kg (iron). The predicted risks for these concentrations were within EPA's acceptable or target risk range for carcinogens (10^{-4} to 10^{-6} risk) and below a target hazard quotient of one for non-carcinogens. Based on this information, and given the depth of the debris relative to the ground surface (at least three feet bgs), and the limited and stable nature of groundwater impacts in this area (see groundwater discussion below), no further action in this area is recommended.

- Wetland Sediments – COIs detected in at least one wetland sediment sample at concentrations exceeding their respective extent evaluation criteria included certain metals, pesticides and PAHs. The lateral extent of contamination in wetland sediments, as defined by COIs concentrations above extent evaluation criteria, was identified as limited to specific areas within the Site boundaries and small localized areas immediately north and east of the Site. The vertical extent of COIs at concentrations above extent evaluation criteria in wetland sediments was identified as limited to the upper one foot of unsaturated sediment.
- Wetland Surface Water – Acrolein, copper, mercury, and manganese were the only COIs detected in at least one wetland surface water sample at concentrations exceeding their respective extent evaluation comparison values. The lateral extent of contamination in wetland surface water, as defined by COIs concentrations above extent evaluation criteria, was identified as limited to localized areas within and immediately north of the Site. A vertical extent evaluation does not apply to this medium.
- Ponds Sediment – Zinc and 4,4'-DDT were the only COIs detected in at least one pond sediment sample at concentrations exceeding their respective extent evaluation comparison values. These exceedences were all limited to the "Small Pond" at the Site,

which effectively defined the extent of contamination in pond sediments. A vertical extent evaluation does not apply to this medium.

- Ponds Surface Water – Arsenic, manganese, silver and thallium were the only COIs detected in at least one pond surface water sample at concentrations exceeding their respective extent evaluation comparison values. The lateral extent of pond surface water contamination, as defined by these exceedences, is limited to the extent of the two ponds. A vertical extent evaluation does not apply to this medium.
- Groundwater – The uppermost water-bearing unit at the Site, Zone A, is generally encountered at an average depth of approximately 10 feet bgs and has an average thickness of approximately 8 feet. Saturated conditions were encountered at depths as shallow as several feet in some borings near the former surface impoundments and in other areas of the Site. Although some semivolatile organic compounds (SVOCs) and metals were detected in Zone A groundwater at concentrations exceeding extent evaluation comparison values, VOCs, particularly chlorinated solvents, their degradation products, and benzene, were the predominant COIs detected in groundwater. The extent of VOCs exceeding extent evaluation comparison values was generally limited to a localized area within the North Area, roughly over the southern half of the former surface impoundments area and a similarly sized area immediately to the south (Figure 5). The next underlying water-bearing unit, Zone B, is generally encountered at an average depth of approximately 20 feet bgs and has an average thickness of approximately 7 feet. The lateral extent of contamination in this zone was limited to VOCs detected in a single well (NE3MW30B) located south of the former surface impoundments. The vertical extent of contamination in groundwater is limited to Zones A and B. Groundwater sampling locations in Zone B and underlying Zone C are shown on Figure 6.

1.2.4 Contaminant Fate and Transport

Potential routes of migration for Site contaminants occur in the primary transport media of air, surface water/sediment (including runoff during storm events), and groundwater. Contaminant migration routes in these media are often interrelated. The physical and chemical characteristics of COIs and their potential transport media affect the degree of contaminant persistence and rate of migration within that media. A detailed contaminant fate and transport discussion ~~will be is~~

provided in the Draft RI Report (PBW, 2011b) currently in preparation, 2011a. For the purposes of this RAM, key considerations from that discussion are highlighted below. The RI Report, once approved, will provide the ultimate results regarding the nature and extent of contamination at the Site, and any findings from the approved RI Report that are not consistent with statements in this RAM will be addressed as appropriate in the Feasibility Study (FS) for the Site.

Potential Air Transport Pathways

Potential airborne contaminants at the Site consist predominantly of particles, as volatile COIs were generally not detected above screening levels in near surface (1 to 2 foot depth interval) soil samples (as specified in the Work Plan, surface soil samples were not analyzed for VOCs) and generally would not be expected to persist in surface soils. Thus potential contaminant transport via air is predominantly in the solid phase. In general, only fine-grained particles are susceptible to transport in air. COIs associated with the scrap metal present in surface fill soils in the South Area and some parts of the North Area would generally not be transported via the air pathway due to the size and density of these materials. Similarly, the predominantly vegetated and moist surface soils/sediments in the North Area are not generally conducive to dust generation and particle transport. The predominant wind direction in the region is from the southeast and south (TCEQ, 2009b). Thus, potential contaminant migration via the air transport pathway would generally be toward the north and northwest from Site Potential Source Areas (PSAs). Surface samples in the North Area generally downwind from the South Area PSAs most likely to contribute metals to surface particles, such as the sand blasting areas, did not indicate elevated concentrations of metals above extent evaluation levels, and thus airborne transport from these areas appears limited. Similarly lead concentrations in surface soil samples collected on Lots 19 and 20 directly west of the Site were relatively low and not indicative of significant air transport of contaminants from Site PSAs via entrainment and subsequent deposition of particles.

Potential Surface Water/Sediment Transport Pathways

The primary surface water/sediment pathways for potential contaminant migration from Site historical PSAs are: (1) erosion/overland flow to wetland areas north and east of the Site from the North Area due to rainfall runoff and storm/tide surge; and (2) erosion/overland flow to the Intracoastal Waterway from the South Area as a result of rainfall runoff and extreme storm surge/tidal flooding events. The low topographic slope of the Site and adjacent areas is not

conductive to high runoff velocities or high sediment loads. Consequently, surface soil particles would not be readily transported in the solid phase. Additionally, the vegetative cover in the North Area serves to minimize soil erosion and resulting sediment load transport with surface water in these areas. Dissolved loads associated with surface runoff from the North Area would likewise be expected to be minimal due to the absence of exposed PSAs, generally low COI concentrations in North Area surface soils/sediments, and the relatively low solubilities of those COIs (primarily; pesticides, PAHs, and/or metals) that are present. Within the South Area, some PSAs, such as the sand blasting area, are exposed and COIs are present above extent evaluation levels at the ground surface. Exposed soils (primarily fill material) and indications of surface soil erosion are present within this area. Local areas of soil erosion and subsequent sediment deposition are apparent at the northern ends of the barge slips in Lots 21 and 22. The inference of surface soil erosion into the ends of the barge slips is supported by similar PAHs in sediment samples from the end of the barge slips and in nearby surface soil samples; however, the general absence of PAHs or other COIs in other areas of the barge slips toward the Intracoastal Waterway or within the waterway itself, suggests limited migration of COI-containing sediments.

Groundwater Transport Pathways

The groundwater pathway for potential transport of groundwater COIs is lateral migration within Zones A and B and vertical migration from Zone A to Zone B in areas where the clay separating Zone A and Zone B pinches out or is of minimal thickness. Vertical migration to deeper water-bearing zones below Zone B is effectively precluded by the thick (greater than 25 feet) and low vertical hydraulic conductivity (7×10^{-9} cm/sec) clay below Zone B.

Evaluations of the groundwater contaminant plume stability, the presence of potential contaminant biodegradation daughter products, and geochemical conditions favorable to biodegradation ~~will be~~ are described in the Draft RI report. These evaluations provide multiple lines of evidence for natural biodegradation of groundwater COIs and potential for limited future migration. The net overarching effect of fate and transport processes within the context of overall groundwater movement rates and directions can be assessed by considering the extent of observed contaminant migration relative to the timeframe over which that migration may have occurred. In the case of the Gulfco site, such an assessment is made through examination of the lateral extent of the primary groundwater COIs in Zone A relative to the operational period of the associated PSA, the former surface impoundments.

Barge cleaning operations at the Site began in 1971. The impoundments are visible in the 1974 aerial photograph in Appendix C. The impoundments were closed in 1982. Thus, contaminants introduced into the impoundments through barge wash waters and associated sludges have had the potential to migrate in groundwater for at least as long as 27 years (1982 to 2009) and potentially as long as 38 years (1971 to 2009). As shown on Figure 5, the lateral extent of contaminants in Zone A is generally limited to an area of approximately 200 ft or less (and in many cases, much less) from the boundary of the former surface impoundments. Dividing this distance by the potential migration period estimates of 27 to 38 years would correspond to contaminant migration rates of approximately 5 ft/year to 7 ft/year, which are consistent with both the low estimated velocity of groundwater in Zone A (discussed in the RI ~~report~~ Report) and further reductions in contaminant migration due to natural biodegradation. The limited extent of contaminant migration, low groundwater velocity and demonstrated contaminant degradation also predict limited potential for future migration, as is further supported by the general stability of the dissolved COI plumes.

1.2.5 Risk Assessment

Risk assessment provides a context for evaluating the significance of site contaminants, and is used to support risk management decisions for a site. Below are the summaries of the risk assessment activities for this Site. Human health and ecological receptors were considered in these evaluations under baseline conditions (i.e., prior to any remediation at the Site).

Human Health Risk Assessment

The Final BHHRA (PBW, 2010a) was submitted to EPA on March 31, 2010. The BHHRA used data collected during the RI to evaluate the completeness and potential significance of potential human health exposure pathways identified in the Conceptual Site Model (CSM) first presented in the Work Plan. These pathways, as updated and presented in the BHHRA, are shown for the South Area in Figure 67 and for the North Area in Figure 7-8. The BHHRA evaluated the potential significance of the complete human health exposure pathways indicated in these figures and concluded that there were not unacceptable cancer risks or non-cancer hazard indices for any

of the five current or future exposure scenarios except for future exposure to an indoor industrial worker if a building is constructed over impacted groundwater in the North Area.

Ecological Risk Assessment

The Final SLERA (PBW, 2010b) used data collected during the RI and was submitted to EPA on May 3, 2010. The SLERA concluded that it was necessary to proceed to the next phase of EPA's ecological risk assessment process by completing a BERA. The BERA addresses the potential for adverse ecological effects to the chemicals of potential ecological concern (COPECs) and receptors identified in the SLERA through a site-specific assessment. The necessity to move the ecological risk process into a site-specific BERA was based on exceedences of protective ecological benchmarks for direct contact toxicity to invertebrates in the sediment in the wetlands and Intracoastal Waterway, soil in the North Area, and surface water in the wetlands as described in the SLERA. No literature-based food chain hazard quotients (HQs) exceeded unity (1) in the SLERA and, as such, adverse risks to higher trophic level receptors are unlikely and were not evaluated further through the BERA process.

Based on the SLERA conclusions and per the study outlined in the BERA Work Plan & Sampling and Analysis Plan (BERA WP/SAP) (URS, ~~2010a~~2010b), the BERA included analytical chemistry analysis and toxicity testing of soil, sediment, and surface water samples corresponding to a gradient of COPEC concentrations. Several Site areas discussed in this RAM were not included in the BERA, as explained in the Final BERA Problem Formulation (URS, 2010a) and Final BERA WP/SAP. As noted in Section 7.0 of the Final BERA Problem Formulation, these areas include: (1) the AST Tank Farm, where a TCRA has now been preformed; (2) the former surface impoundments cap, where cap repair activities will be performed as part of the operation and maintenance program described in Section 1.2.3 above; and (3) South Area soils, where the nature of the disturbed habitat and past, current and anticipated future land use (including the restrictive covenants for only commercial/industrial land use) obviated the need for consideration of soil exposure pathways in this area in the BERA.

Figures ~~8 and 9~~ and 10 show the relevant pathways and receptors of potential concern that were evaluated in the BERA. The BERA data, as ~~first~~ presented in the PSCR (URS, ~~2010b~~2010c), indicate the following:

- The testing of *Neanthes arenaceodentata* showed no statistically significant differences between the North Area soil samples and the reference samples.
- Toxicity testing of wetland sediment using *Neanthes arenaceodentata* and *Leptocheirus plumulosus* showed no statistically significant differences between the Site wetland sediment samples and the reference wetland samples for either the growth or mortality endpoints.
- The toxicity testing of wetland surface water using *Artemia salina* showed no consistent mortality trends.
- Toxicity testing of Intracoastal Waterway sediment using *Neanthes arenaceodentata* and *Leptocheirus plumulosus* showed no statistically significant differences between the Site Intracoastal Waterway sediment samples and the Intracoastal Waterway reference samples for either the growth or mortality endpoints.
- There were no observable trends between concentration, benchmark exceedences, and observed toxicity.

These data suggest that adverse ecological risks from direct exposure to invertebrates in the soils, sediments and surface water are unlikely. ~~Accordingly and consistent with discussions with EPA and TCEQ representatives in the BERA data review and planning meeting on December 1, 2010, ecological-based PRGs were not developed for this Site.~~

The Draft BERA Report (URS, 2011) documenting the above conclusions is currently in preparation; being revised based on EPA comments received on March 2, 2011. The BERA Report, once approved, will provide the ultimate determination of actual ecological risks for the Site, and any BERA findings that are not consistent with statements in this RAM will be addressed as appropriate in the FS for the Site.

2.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

2.1 INTRODUCTION

As described in EPA guidance (EPA, 1988) the remedial alternatives development and screening process consists of the following six general steps:

- Development of remedial action objectives;
- Development of general response actions;
- Identification of volumes or areas to which the general response actions might be applied;
- Identification and screening of technologies applicable to each general response action;
- Identification and evaluation of technology process options to select a representative process for each technology type; and
- Assembly of representative technologies into alternatives.

Consistent with the goal of organizing this RAM to correspond to the suggested format for the technology and alternative screening sections of the FS, Sections 2.2 through 2.4 below describe how the first five steps of this process are used to select remedial technologies for consideration at the Site. The assembly of these technologies into remedial alternatives in the sixth step is described in Section 3.1.

2.2 REMEDIAL ACTION OBJECTIVES

RAOs consist of medium-specific goals for protecting human health and the environment. As such, RAOs are developed for those exposure pathways identified as posing an unacceptable risk to either: (1) human receptors as described in the BHHRA; and/or (2) ecological receptors based on data developed in the BERA. As noted previously, the Draft BERA (URS, 2011) is currently ~~in preparation and has not been reviewed by~~ being revised based on EPA review comments.

Based on data presented in the approved PSCR and discussions with EPA and TCEQ representatives on December 1, 2010, -it is anticipated that the RAOs for this Site will not be based on ecological endpoints given the lack of potential risk to these receptors. ~~RAOs were identified for two areas/media at the Site based on~~ The approved BERA will determine the actual ecological risks for the Site, and any BERA findings that are not consistent with statements in this RAM will be addressed as appropriate in the FS for the Site. As such, RAOs for the Site were

identified to address concerns related to future human health exposure: (1) the Former Surface Impoundments; and (2) associated with North Area groundwater. The RAOs for these areas are described below:

2.2.1 Former Surface Impoundments

As noted previously, the former surface impoundments contain residual barge cleaning wash water sludge that was reportedly solidified when the impoundments were closed by capping in 1982 in accordance with the Texas Water Commission approved plan (Carden, 1982). This residual sludge, along with wash waters stored in the impoundments prior to closure, is believed to be the source of the VOCs and other chemicals detected in North Area groundwater in the impoundments vicinity. The cap inspection described previously documented the cap to be in generally good condition with no significant desiccation cracks or erosion features and generally acceptable side slopes, although some penetrations, surface debris, large bushes and surface rutting were observed. An inspection after Hurricane Ike did not indicate significant damage. In addition, a localized area of buried debris was identified immediately south of the former surface impoundments. Based on this information, the RAOs for this area are: (1) to reduce the potential for waste (i.e., residual sludge and/or buried debris) exposure, through future surface erosion and/or cap penetration; and (2) to reduce the potential for increased contaminant loading from waste to groundwater through cap failure.

Numeric PRGs have not been calculated to support this RAO because the risk issue of concern identified for the former surface impoundments is not quantifiable. Potential future exposure to buried debris and waste in the former surface impoundments is highly uncertain and may not occur, therefore, numeric PRGs are not appropriate.

2.2.2 Groundwater

The NEDR and BHHRA and Draft RI Report note that groundwater in affected water-bearing units at the Site (Zones A and B) and the next underlying water-bearing unit (Zone C) is not useable as a drinking water source due to naturally high total dissolved solids (TDS) concentrations. Consequently, the only potentially unacceptable human health risks associated with COIs detected in Site groundwater are for the pathway involving volatilization of VOCs from North Area groundwater to a hypothetical indoor air receptor. This conclusion is based on

the continued stability of the current COI plume, both in terms of lateral extent in Zones A and B and the absence of COIs in deeper water-bearing units. Restrictive covenants currently in place for Lots 55 through 57 (shown on Figure 2), which encompass the area of the VOC plume (as shown on Figure 5), require EPA and TCEQ notification and approval prior to construction of any buildings on these parcels. The covenants (included as Appendix B to this memorandum) also advise that response actions, such as protection against indoor vapor intrusion, may be necessary prior to building construction. Thus, the RAOs for contaminated groundwater are: (1) to verify, on an ongoing basis, the continued stability of the VOC plume in Zones A and B, both in terms of lateral extent and absence of impacts above screening levels to underlying water bearing units; and (2) to maintain, as necessary, protection against potential exposures to VOCs at levels posing an unacceptable risk via the groundwater to indoor air pathway.

As described in the SLERA (PBW, 2010b), there are no currently complete exposure pathways for ecological receptors to contact COIs in groundwater and, as such, this RAO was developed to be protective of potential future exposure to human receptors. Numeric PRGs were not calculated for this pathway since the deed restrictions will effectively prevent future exposure.

2.3 GENERAL RESPONSE ACTIONS

While RAOs are generally focused on specific potential exposure pathways, media and/or contaminant levels, general response actions describe the types of actions to be taken to satisfy the identified RAOs. As described in EPA guidance (EPA, 1988), general response actions may include treatment, containment, excavation, extraction, disposal, institutional controls, or a combination of those. General response actions, along with preliminary estimates of the area/volumes to be addressed by those response actions (as applicable) are described below for each of the two areas/media for which RAOs were identified in Section 2.2. For the purposes of this RAM, the “no action” response action is not included in the discussions below; however, consistent with EPA guidance (EPA, 1988), the “no action” alternative will be evaluated in the FS.

2.3.1 Former Surface Impoundments

The RAOs for the former surface impoundments area are: (1) to reduce the potential for waste exposure through future surface erosion and/or cap penetration; and (2) to reduce the potential for

increased contaminant loading from waste to groundwater through cap failure. The general response actions to address these RAOs for the former surface impoundment residual wastes are:

- Containment;
- On-site Treatment; and
- Excavation/Off-site Management.

A containment-based response action would entail either repair/upgrade or replacement of the existing former surface impoundment cap and extension of the upgraded cap over the buried debris area. An on-site treatment-based response action would include cap removal followed by either: (1) in-situ treatment through physical, biological, or chemical means; or (2) waste/debris excavation and treatment followed by on-site disposal of the treated material. An off-site management-based response action would involve excavation of the former surface impoundment sludge material and buried debris followed by shipment to an off-site facility for treatment, and/or disposal.

The former surface impoundments share many similarities with municipal landfill sites addressed under CERCLA. As described in EPA's *Feasibility Study Analysis for CERCLA Municipal Landfill Sites* (EPA, 1994b), municipal landfill (MLF) sites on the NPL are characterized by large volumes of heterogeneous waste, frequently including municipal waste co-disposed with industrial and/or hazardous waste. The volume and characteristics of wastes at these sites along with the disposal history is variable and often uncertain, with typical COIs including a variety of VOCs, SVOCs, and potentially inorganic compounds and metals (EPA, 1994b). The former surface impoundments at the Gulfeo site contain an undetermined volume of waste, consisting of a heterogeneous mixture of residual industrial sludge from former barge cleaning operations and soils reportedly added to stabilize the sludge at the time of closure. Similarly, the specific volume of buried debris observed immediately south of the former surface impoundments has not been determined.

EPA has established containment as the presumptive remedy for CERCLA MLFs (EPA, 1993). This designation was based on a review of remedial alternatives analyses performed at multiple MLFs (EPA, 1991) and is consistent with EPA expectations that containment technologies will generally be appropriate for waste that poses relatively low long-term threat or where treatment is

impracticable (EPA, 1994b). As defined in the presumptive remedy guidance (EPA, 1993), containment relates primarily to containment of the landfill mass and/or treatment of landfill gas (produced by the decay of putrescible material in municipal waste within the landfill). Containment may also include leachate or groundwater control at the landfill perimeter, and/or institutional controls, as necessary. Potential long-term groundwater response actions, if any, at MLFs are beyond the scope of the presumptive remedy. One of the purposes of a presumptive remedy is to facilitate a streamlined evaluation of remedial alternatives during the FS. In effect, the establishment of containment as a presumptive remedy fulfills the FS requirements for screening of potential remedial technologies and assembly of remedial alternatives, and allows the remedial alternatives evaluation to proceed directly to the screening of remedial alternatives.

Given the similarities of the former surface impoundments to CERCLA MLFs, the technology screening performed at multiple MLF sites to support containment as a presumptive remedy (EPA, 1994b) can effectively serve as the technology screening for the former surface impoundments at the Gulfeo site. As such, Section 2.4 of this RAM includes a discussion of the technology identification and screening process for containment-based alternatives only. Similarly, Section 3.0 assembles and evaluates only containment-based alternatives. Since putrescible wastes were not reported within the former surface impoundments and were generally not observed in the debris area, production of landfill gas is not a likely concern and thus landfill gas management has not been included as a component of the containment-based remedial alternatives considered in Section 3.0. In the same way, given the nature of the waste material within the former surface impoundments and the buried debris area, the shallow water table at the Site, and the demonstrated extent and stability of the associated VOC groundwater plume, leachate collection and perimeter groundwater control are not included in the containment alternatives discussed for this area in Section 3.0.

The former surface impoundments and the buried debris area cover a projected area of approximately 3 acres, as shown on Figure 4. This acreage encompasses the entire area within the existing cap and the projected boundary of the buried debris area as estimated from the aerial photograph in Appendix C.

2.3.2 Groundwater

The RAOs for groundwater are: (1) to verify, on an ongoing basis, the continued stability of the VOC plume in Zones A and B, both in terms of lateral extent, and the absence of impacts above screening levels to underlying water-bearing units; and (2) to maintain, as necessary, protection against potential exposures to VOCs at levels posing an unacceptable risk via the groundwater to indoor air pathway. The general response actions to address these RAOs for groundwater are:

- Monitoring/Institutional Controls;
- Containment; and
- In-situ Treatment.

A monitoring/institutional controls response action would include ongoing groundwater monitoring to demonstrate continued plume stability and review/evaluation of the current restrictive covenant requiring EPA and TCEQ notification and approval prior to construction of buildings and advising protection against indoor vapor intrusion as part of any building construction. Continued evaluation of the currently observed natural biodegradation of COIs in Site groundwater is an inherent part of the monitoring component of this alternative. A containment response action could entail either construction of a physical barrier, such as a slurry wall to contain affected groundwater or a groundwater collection and treatment system to provide hydraulic containment. An in-situ treatment response action would involve injection of reagents to facilitate biological or chemical treatment of the VOCs such that concentrations were reduced to levels protective of the potential groundwater to indoor air pathway and potential future migration. The identification and screening of potential technologies for these general response actions is performed in Section 2.4.2. The general extent of groundwater contamination as indicated by VOC concentrations in Zone A exceeding their respective extent evaluation comparison values is shown on Figure 5. VOC isoconcentration maps providing the basis of the extent area shown in this figure are provided in the NEDR. Additional explanation of these data will be provided in the Draft RI Report (PBW, 2011b2011a).

2.4 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Prior to developing remedial alternatives for the general response actions described in Section 2.3, it is necessary to identify potentially applicable remedial technologies for each area/medium and screen the technologies to select only those processes that would be potentially effective at meeting the RAOs and are implementable. In the sections below, potentially applicable remedial

technologies and process options are identified for the general response actions and are screened in accordance with procedures in EPA guidance (EPA, 1988). The following screening criteria were applied to each technology/process option to determine if the technology was applicable to the specific general response action being considered, and thus worthy of more detailed analysis:

- Effectiveness
 - Potential effectiveness in meeting RAOs
 - Potential impacts to human health and the environment
 - Reliability/applicability to Site COIs and conditions
- Implementability
 - Technical/administrative feasibility of implementing the technology
- Cost
 - Capital/Operation and Maintenance (O&M) costs relative to other technologies (i.e., low, moderate, high, etc.)

2.4.1 Former Surface Impoundments

The general response actions for the former surface impoundments are:

- Containment;
- On-site Treatment; and
- Excavation/off-site management.

As described in Section 2.3.1, the former surface impoundments are similar to CERCLA MLFs for which EPA has identified containment as a presumptive remedy. As such, the technology screening presented in Table 2 for this area focuses on containment and related technologies. Institutional and access controls are evaluated in Table 2 as supporting technologies for a containment-based response action and not as a stand-alone technology. Consistent with the former surface impoundments RAOs of: (1) reducing the potential for waste (i.e., residual sludge and/or buried debris) exposure, through future surface erosion and/or cap penetration; and (2) reducing the potential for increased contaminant loading from waste to groundwater, through cap failure, three capping technologies were evaluated in Table 2. Of these, repair and upgrade of the

existing cap was retained for use in developing potential remedial alternatives based on a higher effectiveness, higher implementability, and lower capital cost as described in Table 2.

2.4.3 — Groundwater

The general response actions for groundwater are:

- Monitoring/Institutional Controls;
- Containment; and
- In-situ Treatment.

Table 32 presents the technologies considered for these general response actions and summarizes the screening process by which these technologies were evaluated. Two monitoring/institutional control technologies (restrictive covenants and groundwater monitoring) were included in this evaluation. Both of these were retained for further evaluation and use in developing remedial alternatives.

Four physical containment technologies were screened in Table 3-2. These included two slurry wall technologies, sheet piling, and permeable reaction walls (designed to let groundwater pass but contain contaminants). Due to very high costs and concerns over potential adverse impacts to large areas of Site wetlands during construction, none of these technologies were retained for further evaluation.

Containment by hydraulic control was considered through the screening of four technologies, groundwater extraction via vertical wells and three subsurface drain technologies (conventional interceptor trenches, single pass trenching drains, and horizontal wells). Due to high costs, and/or low implementability for the subsurface drain technologies, the vertical extraction well option was retained as the hydraulic control technology for further evaluation and use in developing remedial alternatives.

Twelve treatment technologies, including two biological process options, nine physical/chemical process options, and one thermal process option, were considered for management of collected groundwater. As noted in Table 32, many of these technologies were characterized by low effectiveness, relatively lower implementability, and/or moderate to high costs. As a result of this

screening, low profile aeration was retained as the aqueous phase treatment technology for further evaluation and use in developing remedial alternatives. Similarly, catalytic oxidation was retained as the vapor phase treatment technology for further evaluation and use in developing remedial alternatives.

Three post-treatment discharge options were considered: on-site discharge through injection wells, off-site discharge to the City of Freeport Publically Owned Treatment Works (POTW), and direct discharge to the Intracoastal Waterway. As detailed in Table 32, the POTW discharge was the surviving option from this screening, due to less stringent treatment requirements (and thus lower treatment costs) and lesser potential implications from any treatment system upsets.

In-situ treatment technologies were evaluated through biological and chemical treatment options. Natural biodegradation of COIs in Site groundwater was retained as part of all remedial alternatives. Due to the low effectiveness and low implementability, neither of these the other two in-situ technologies at the Site, neither was retained for further evaluation.

3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

Consistent with the remedial alternatives development and screening process described in EPA guidance (EPA, 1988) and summarized previously in Section 2.1 of this RAM, the sixth (and final step) of the process is the assembly of representative technologies retained from the screening evaluation into remedial alternatives. This step is described in Section 3.1, below, for each of the two affected media/areas for which RAOs were identified. Section 3.2 provides a screening evaluation of these alternatives for effectiveness, implementability, and cost as recommended in EPA guidance (EPA, 1988). A detailed analysis of these alternatives against the nine CERCLA evaluation criteria will be performed in the FS to be prepared upon approval of this RAM.

3.1 DEVELOPMENT OF ALTERNATIVES

Table 43 illustrates how surviving technology options for the former surface impoundments, and affected groundwater were combined/assembled into three Site-wide remedial alternatives. Brief descriptions of each of these alternatives are provided below:

- Alternative 1 – No Action. Consideration of a no action alternative is specified in EPA guidance (EPA, 1988). This alternative serves as a baseline against which other alternatives are evaluated. Under this alternative, no remedial action or institutional controls (beyond those currently in place) are implemented. This alternative effectively represents the baseline conditions evaluated in the BERA and BHHRA.
- Alternative 2 – Former Surface Impoundments Containment and Groundwater Controls/Monitoring. This alternative uses ~~containment and~~ institutional control technologies and monitoring to address RAOs for the former surface impoundments, and affected groundwater. It includes the following: (1) ~~upgrade/repair of the existing cap at the former surface impoundments through surface debris and brush removal from the cap, grading/compaction of the existing clay cap, placement of an additional clay layer over the existing cap, extension of the existing cap over the nearby buried debris area, placement of a topsoil layer over the clay cap, and vegetation of the cap surface;~~ (2) ~~deed recordation of the former surface impoundment and buried debris area, including filing of a restrictive covenant prohibiting disturbance of the cap;~~ (3) ~~fencing (three-strand~~

barbed wire) of the capped area; (4) review/evaluation of the current restrictive covenants prohibiting groundwater use on Lots 55 through 57 of the Site and requiring protection against indoor vapor intrusion for building construction on these lots; and (52) annual groundwater monitoring to confirm continued stability of the affected groundwater plume through natural biodegradation and other processes. It should be noted that the current restrictive covenants described in Item 41 above are included in Appendix B herein.

- Alternative 3 – Impoundment and Groundwater Containment. This alternative uses containment technologies to addresses RAOs for the former surface impoundments, and affected groundwater. It includes the following: (1) upgrade/repair of the existing cap at the former surface impoundments through surface debris and brush removal from the cap, grading/compaction of the existing clay cap, placement of an additional clay layer over the existing cap, extension of the existing cap over the nearby buried debris area, placement of a topsoil layer over the clay cap, and vegetation of the cap surface; (2) deed recordation of the former surface impoundment and buried debris area, including filing of a restrictive covenant prohibiting disturbance of the cap; (3) fencing (three strand barbed wire) of the capped area; (4) review/evaluation of current restrictive covenants prohibiting groundwater use on Lots 55 through 57 of the Site and requiring protection against indoor vapor intrusion for building construction on these lots; (52) installation/operation of a series of vertical groundwater extraction wells to provide hydraulic control of affected groundwater; (63) treatment of collected groundwater using low profile aeration with off-gas treatment by catalytic oxidation; (74) discharge of treated groundwater to the City of Freeport POTW; and (85) annual groundwater monitoring to verify the effectiveness of groundwater hydraulic control.

3.2 SCREENING OF ALTERNATIVES

3.2.1 Introduction

As described in EPA guidance (EPA, 1988), remedial alternatives are developed to meet the identified RAOs for each area/medium of interest. During screening, the assembled alternatives are evaluated to ensure that they protect human health and the environment from each potential pathway of concern at the Site. Thus for the alternative screening, the assembled alternatives are

evaluated against short-term and long-term aspects of effectiveness, implementability, and cost. These criteria are defined in the EPA guidance (EPA, 1988) for alternatives screening as follows:

- Effectiveness - This criterion pertains to the effectiveness of each alternative in protecting human health and the environment and the reductions in toxicity, mobility and volume that it will achieve. Short-term effectiveness is evaluated relative to the alternative construction and implementation period. Long-term effectiveness is evaluated relative to the period after the remedial action is complete. Reduction of toxicity, mobility, or volume refers to changes in contaminant or contaminated media characteristics by the use of treatment that decreases inherent risks or threats.
- Implementability – This criterion pertains to the technical and administrative feasibility of constructing, operating, and maintaining each alternative. Technical feasibility refers to the ability to construct, reliably operate, and meet technology-specific requirements until a remedial action is complete. It also includes the operation, maintenance, replacement, and monitoring, or technical components of alternatives into the future after the remedial action is complete (as applicable). Administrative feasibility includes both the ability to obtain any necessary approvals from regulatory agencies and the availability of treatment, storage, and disposal services and capacity.
- Cost – Both capital and O&M costs are considered for this criterion. Cost evaluation is performed on a present worth basis to evaluate expenditures that occur over different time periods.

3.2.2 Alternative 1 – No Action

The no action alternative is not effective at providing additional protection of human health and the environment with regard to the identified RAOs in either the short- or long-term. ~~Similarly, this~~ This alternative achieves no ~~may achieve some~~ reductions in COI ~~toxicity, mobility and volume due to natural biodegradation; however, verification of those reductions through groundwater monitoring is not included in this alternative.~~ Since the alternative entails no action, it is readily implemented and has no associated capital or operation and maintenance (O&M) costs. CERCLA requires evaluation of a no action alternative, so Alternative 1 is retained for detailed analysis in the FS.

3.2.3 Alternative 2 – Impoundment Containment and Groundwater Controls/Monitoring

Alternative 2 addresses the former surface impoundments RAOs of reducing the potential for waste exposure and reducing the potential for increased contaminant loading from the impoundment wastes to groundwater by upgrading the existing cap and implementing institutional controls and fencing to protect the cap. These remedy components are effective in protecting human health and the environment during the short term as no wastes would be exposed during construction, and they also provide long term protection for the RAOs. No reductions in toxicity, mobility and volume of the impoundment wastes through treatment are achieved by this alternative.

The groundwater RAOs of verifying continued VOC plume stability and maintaining protection against potential VOC exposures via the groundwater to indoor air pathway are addressed by the groundwater monitoring program and by the current restrictive covenants described previously. These alternative components are effective in protecting human health and the environment in accordance with the groundwater RAOs. No reductions in toxicity, mobility and volume of groundwater contamination through added treatment are achieved by this alternative; however, it should be noted that the natural attenuation processes occurring in Site groundwater provide natural biological treatment that would, over time, be expected to provide a reduction in toxicity, mobility, and/or volume. This alternative may achieve some reductions in COI toxicity, mobility and volume over time due to natural biodegradation processes. An evaluation of those reductions is provided through the groundwater monitoring component of this alternative.

All components of Alternative 2 are readily implemented. ~~Cap upgrades, fencing,~~ institutional Institutional controls and monitoring programs are all commonly used technologies that are very feasible from both technical and administrative perspectives.

A preliminary cost evaluation of Alternative 2 for the purposes of this alternative screening is provided in Table 5.4. Key assumptions regarding ~~cap upgrade material volumes, fencing lengths, and~~ monitoring program requirements are listed in this table. The preliminary total present worth cost, including contingencies for this alternative is projected at \$ ~~700~~250,000.

This preliminary screening determined that Alternative 2 is effective, implementable and of estimable cost. Thus Alternative 2 is retained for a more detailed analysis in the FS.

3.2.4 Alternative 3 – Impoundment and Groundwater Containment

~~Alternative 3 addresses the former surface impoundments RAOs of reducing the potential for waste/debris exposure and reducing the potential for increased contaminant loading from the impoundment wastes to groundwater by upgrading the existing cap, and implementing institutional controls and fencing to protect the cap. These remedy components are effective in protecting human health and the environment during the short term as no wastes would be exposed during construction, and they also provide long term protection for the RAOs. No reductions in toxicity, mobility and volume of the impoundment wastes through treatment are achieved by this alternative.~~

The groundwater RAOs of verifying continued VOC plume stability and maintaining protection against potential VOC exposures via the groundwater to indoor air pathway are addressed through hydraulic control of groundwater and by the restrictive covenants described previously. Hydraulic control of groundwater is maintained by groundwater extraction, treatment by air stripping and discharge to the City of Freeport POTW. These alternative components are effective in protecting human health and the environment in accordance with the groundwater RAOs. Although some reductions in toxicity, mobility and volume of groundwater contamination through treatment are achieved by this alternative, the groundwater objective is containment and thus toxicity, mobility and volume reductions to levels obviating the need for ongoing containment are not expected. The natural ~~attenuation~~biodegradation processes occurring in Site groundwater ~~that provide natural biological treatment mentioned previously may~~ also over time provide reductions in toxicity, mobility, and/or volume.

All components of Alternative 3 are readily implemented. ~~Off site waste disposal, cap upgrades, fencing, institutional~~Institutional controls and groundwater extraction and treatment are all commonly used technologies that are very feasible from both technical and administrative perspectives. ~~Adequate off-site waste management capacity is available through multiple commercial facilities.~~ Although not confirmed, it is reasonable to expect adequate sanitary sewer line and treatment capacity is available at the City of Freeport POTW. In-depth discussions with

the City regarding capacity, pre-treatment requirements, etc. would be needed prior to further consideration of this alternative.

A preliminary cost evaluation of Alternative 3 for the purposes of this alternative screening is provided in Table 6-5. Key assumptions regarding ~~cap upgrade material volumes, fencing lengths,~~ groundwater extraction/treatment rates, and monitoring program requirements are listed in this table. The preliminary total present worth cost, including contingencies for this alternative is projected at \$ 3,500,000,000.

This preliminary screening determined that Alternative 3 is effective, implementable and of estimable cost. Thus Alternative 3 is retained for a more detailed analysis in the FS.

4.0 CONCLUSIONS

The purpose of the RAM is to develop a range of remedial alternatives and screen those alternatives in relation to the RAOs in order to allow a more detailed analysis of alternatives in the FS. RAOs were identified for two areas/media at the Site based on concerns related to future human health exposure: ~~(1) the Former Surface Impoundments; and (2) associated with North Area groundwater.~~ The RAOs for the former surface impoundments area are: ~~(1) to reduce the potential for waste exposure through future surface erosion and/or cap penetration; and (2) to reduce the potential for increased contaminant loading from waste to groundwater through cap failure.~~ The RAOs for groundwater are: (1) to verify, on an ongoing basis, the continued stability of the VOC plume in Zones A and B, both in terms of lateral extent, and the absence of impacts above screening levels to underlying water-bearing units; and (2) to maintain, as necessary, protection against potential exposures to VOCs at levels posing an unacceptable risk via the groundwater to indoor air pathway.

General response actions were identified to address the above RAOs. Remedial technologies potentially applicable to those general response actions were screened and the surviving technologies were then assembled into remedial alternatives. Based on this process the following remedial alternatives were developed:

- Alternative 1 – No Action. Under this alternative, no remedial action or institutional controls (beyond those currently in place) are implemented. This alternative serves as a baseline against which other alternatives are evaluated.
- Alternative 2 – Former Surface Impoundments Containment and Groundwater Controls/Monitoring. This alternative uses ~~containment and institutional control~~ technologies to address RAOs for the former surface impoundments, and affected groundwater. It includes the following: (1) ~~upgrade/repair of the existing cap at the former surface impoundments through surface debris and brush removal from the cap; grading/compaction of the existing clay cap; placement of an additional clay layer over the existing cap; extension of the existing cap over the nearby buried debris area; placement of a topsoil layer over the clay cap; and vegetation of the cap surface;~~ (2) ~~deed recordation of the former surface impoundment and buried debris area, including filing of a restrictive covenant prohibiting disturbance of the cap;~~ (3) ~~fencing (three strand~~

barbed wire) of the capped area; (4) review/evaluation of current restrictive covenants prohibiting groundwater use on Lots 55 through 57 of the Site and requiring protection against indoor vapor intrusion for building construction on these lots; and (52) annual groundwater monitoring to confirm continued stability of the affected groundwater plume.

- Alternative 3 – Impoundment and Groundwater Containment. This alternative uses containment technologies to addresses RAOs for the former surface impoundments, and affected groundwater. It includes the following: (1) upgrade/repair of the existing cap at the former surface impoundments through surface debris and brush removal from the cap, grading/compaction of the existing clay cap, placement of an additional clay layer over the existing cap, extension of the existing cap over the nearby buried debris area, placement of a topsoil layer over the clay cap, and vegetation of the cap surface; (2) deed recordation of the former surface impoundment and buried debris area, including filing of a restrictive covenant prohibiting disturbance of the cap; (3) fencing (three strand barbed wire) of the capped area; (4) review/evaluation of current restrictive covenants prohibiting groundwater use on Lots 55 through 57 of the Site and requiring protection against indoor vapor intrusion for building construction on these lots; (52) installation/operation of a series of vertical groundwater extraction wells to provide hydraulic control of affected groundwater; (63) treatment of collected groundwater using low profile aeration with off-gas treatment by catalytic oxidation; (74) discharge of treated groundwater to the City of Freeport POTW; and (85) annual groundwater monitoring to verify the effectiveness of groundwater hydraulic control.

These three alternatives were screened against the initial criteria of short-term and long-term aspects of effectiveness, implementability, and cost. As a result of that process, all three were retained for a detailed analysis relative to the full suite of nine CERCLA evaluation criteria in the FS.

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